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(54) Method and apparatus for rapid automatic focusing an image of an object.

(57) An automatic focusing system comprises a lens system or assembly (11) which is fixed in its location along an optical axis (17) between an object (1) and its image (19). The focusing of the object (1), which may vary its position along the optical axis (17), occurs through adjusting a detector or moving an imager (13) to the position in image space where the image space is focused on its image plane (19). The system is structured to facilitate this focusing in an automatic and very rapid manner to accommodate rapid changes in the location of the object (1) along the optical axis (17), e.g. in bar code reading systems.

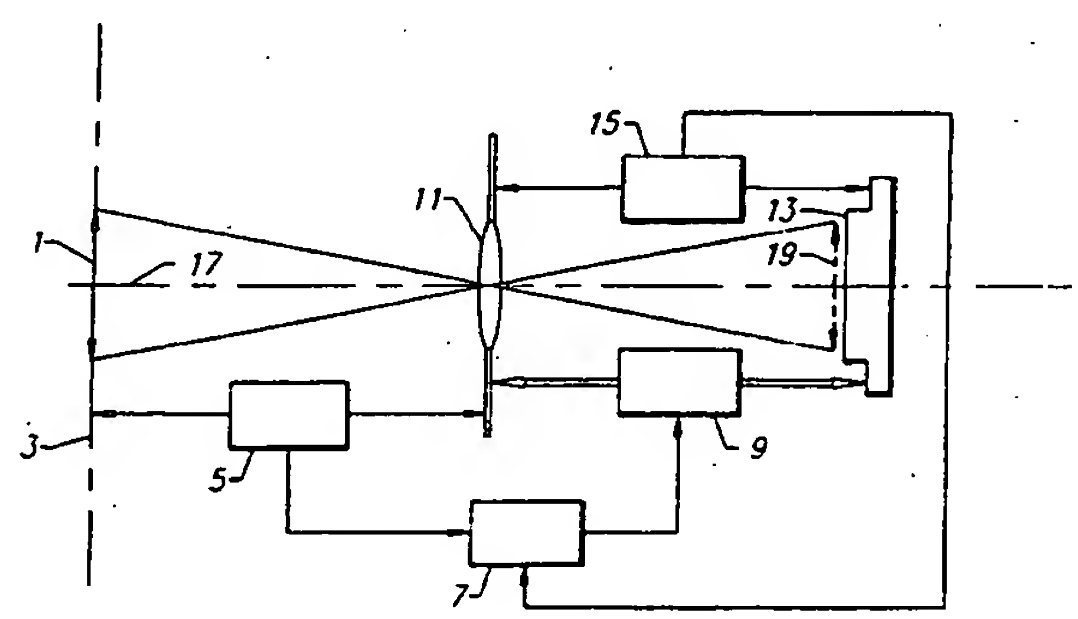


FIG. 1

The present invention relates to rapid image focusing of objects located in object planes which fluently change their distance from the focusing apparatus. An example occurs with an apparatus for sequentially focusing images of an objects located on the surface of a series of articles of different heights being transported along a predetermined path such as on a conveyor belt.

Many optical scanning applications where target distances can change rapidly require fast, accurate and automatic focusing systems. For example, a package scanning system, such as one used for reading postal bar code labels from surfaces of boxes or packages on a moving conveyor, must necessarily be capable of reading labels from boxes of all sizes. Since such system is based on an optical configuration which must quickly adapt to reading the bar code labels that are located at differing heights above the conveyor, a highly responsive optical reading system is required.

Typically, optical systems which must be capable of automatic focusing over a predetermined range of object distances utilize lens element separation changes to accomplish the required imaging on a fixed image plane. Electrical range detectors and controlling systems for operating the mechanical adjustments are part of the systems. In the world of commercial photography, automatic focusing cameras allow for focusing by the movement of the lens assemblies in relation to the location of a fixed image plane where the film would be located. Such mechanically adjustable lenses are bulky, having a high mass which drastically slows the response time of the focusing adjustment. While acceptable in the field they were designed for, such systems are undesirable in modern needs for high speed detection and electronic reading capability for scanned optical information.

According to one aspect of the invention there is provided an apparatus and method where automatic focusing of an optical receiving system occurs by moving the image plane with respect to an optics or lens system which is fixed.

According to another aspect of the invention, there is provided focusing for objects located at differing distances from a lens of viewing apparatus through the use of an automatic and imager position adjustment relative to the image plane wherein the image of the object will be focused by the lens.

According to an further aspect of the invention, there is provided an apparatus an method wherein a lens system or assembly is fixed in its location along an optical axis between an object and the resulting image; the focusing of an object, which may vary its position along the optical axis, occurs through adjusting a detection medium or an imager to the position in image space where the image is focused in its image plane. The design may be structured to facilitate this focusing in an automatic and very rapid manner to accommodate rapid changes in the location of the object along the optical axis.

According to yet another aspect, an apparatus comprises a first member that is held in a fixed position relative to the optical axis, a second member adapted to hold an imager and movable relative to the first member, and an actuator attached to the second member to move the second member relative to the first member in response to a predetermined drive signal to position the imager at the image plane at which the image is in focus.

The actuator may be a speaker driver including a speaker magnet that moves in response to the drive signal and a shaft attached to the speaker magnet to move with the speaker magnet, the speaker magnet being attached to the first member and the shaft being attached to the second member. Alternatively, the actuator may be a linear motor including a motor magnet and a motor coil, the motor magnet being attached to one of the first or second members and the motor coil being attached to the other of the first or second members; e.g. the motor magnet may be attached to the first member and the motor coil attached to the second member. Such apparatus may further comprise sensor circuitry for producing an imager position signal representing the position of the imager along the optical axis and processor circuitry for processing the imager position signal, detecting the difference between the imager position and the location of the image plane along the optical axis, and producing the drive signal based on the detected different. The sensor circuitry may include a linear variable differential transformer. Moreover, the second member may be a linearly actuable shaft of a linear motor. The focusing device may be an optical element for producing the image of the object, e.g. the optical element may be a lens system held stationary relative to the first member.

According to another perspective, an aspect of the invention is a method for rapidly forming a focused optical image of an object on an imager in which the image is focused in an image plane that intersects an optical axis, the method comprising the steps of (a) placing a first member supporting a stationary optical element at a fixed position along the optical axis, (b) providing a movable second member holding an imager, (c) generating a drive signal indicative of the distanc- along the optical axis between the focus of the image and the location of the stationary optical element, and (d) selectively moving the second member relative to the first member in response to a drive signal to position the imager at the image plane. In generating the drive signal of element (c), one may either use information of the distance of the object from the

stationary optical element or information based upon the contrast or sharpness (i.e. quality) of the image.

Yet a further aspect of the invention presents a system which comprises a means for detecting the location of the object along the optical axis or the quality of the image and feeding this information to a controller which determines the proper location for setting an imager at the image plane where the image will be in focus, the controller emitting a drive signal to an actuator which forces the imager to this image plane, allowing detection of the optical information from the object.

Alternative aspects of the invention are exemplified by the attached claims.

For a better understanding of the invention and to show how the same may be carried into effect, reference will now be made, by way of example, to the accompanying drawings, wherein:

Figure 1 is a schematic diagram showing the general layout for a focusing system in which an actuator creates linear motion for an imager along an optical axis;

Figure 2 is a schematic diagram showing a focusing system in which an imager is allowed to rotate about a pivot point located off an optical axis;

Figure 3 is a schematic diagram of an imager unit, wherein an imager will move with its image plane at right angles to an optical axis but through a slight arc;

Figure 4 shows an embodiment of an imager located on a cantilever portion of a plate which is driven to flex about an axis;

Figure 5 shows an embodiment in which an imager is driven by a moving coil audio speaker;

Figure 6 is a detailed drawing showing an optical system using a pivoting imager;

Figure 7 is a schematic drawing showing use of an electrostrictive element as an actuator;

Figure 8 shows an embodiment where imager control is determined by through-the-lens evaluation of image quality; and

Figure 9 illustrates application of a system for use in reading objects carried along a moving conveyor belt system.

Embodiments of the invention are now to be described wherein focusing of the image of an object is accomplished by moving a detector (CCD imager, film, etc.) to the image plane instead of moving the optical elements within a lens assembly or moving the lens assembly itself. This approach has been discovered to have technical advantages because the mass of the moving element can be significantly reduced, resulting in faster focusing for a given amount of power. Further, when a lens group within a lens system is moved, one must also consider the effects of aberrations caused by tilt and axial decentering of the moving elements on the modulation transfer function of the system.

The motion of the image plane can be pure linear motion along the optical axis, or it can move along an arc tangential to the optical axis and having a radius large in comparison to the amount of movement required in a direction along the optical axis. This results in a small angular motion of the imager. However, depending on the magnitude of the radius of the arc, which is set tangential to the optical axis, linear motion in a direction along the optical axis can well be approximated. Also to be considered for radial movement of the imager is that the center point of the imager, defined as being the location on the imager of the optical axis when the imager's image plane is perpendicular to the optical axis, will move off the optical axis slightly as the imager is moved along an arc. This can cause some distortion in the received image by the imager which will need consideration in view of the particular application requirements.

Either form of motion is applicable with one or two dimensional imagers with the caveat of possible distortion problems mentioned above regarding movement along an arc. The requirements utilized in these preferred embodiments were not adversely affected by such movement. Clearly, this potential problem is a matter of degree and can be designed around within the present state of art in the field.

In practical applications the inventor has obtained successful results with a total range of movement of the imager along the optical axis of 0.0305 cm (0.012 inches) or less. It will be clear from the following description that values for ranges of imager movement can be larger or much smaller than the above range by proper design of the optical system, including control for the location of the fixed lens in relation to the object ranges to be expected.

On the simplest scale the mechanism may be composed of two pieces, one being a moving frame containing an imager and the other being a stationery frame containing the lens or lens assembly. For rapid focusing of the optical image on an imager, an actuator is attached to the moving frame to move it relative to the stationary frame. The actuator responds to a drive signal from a controller for positioning the imager at the imaging plane.

In Figure 1, an object 1 is positioned in an object plane 3 along optical axis 17. This object is considered capable of changing its position along optical axis 17 in relation to lens assembly 11 which is also mounted on the optical axis at a fixed location. A detecting device or imager 13 is movably positioned along optical axis 17 to detect an image 19 focused at its image plane and occurring

from object 1.

Imager 13 may be a one or two dimensional CCD array, a transistorized two dimensional array image receiver, or a simple chemical film system. It is clear to one skilled in the art that imager 13 could be any of a multitude of devices well-known in the prior art.

As object 1 moves to different locations along optical axis 17 the automated system comprises a detector 5 for determining and measuring the distance of the object 1 from lens 11, and an actuator 9 connected in relation to lens 11 to position imager 13 at the image plane for image 19. A controller 7 is connected to receive data from detector 5 for determining the amount of control needed to be applied to actuator 9 for relocating imager 13 to any new image plane wherein the image is to be focused as caused by a change in the location of object 1.

Although not generally needed, a distance measuring device 15 can be connected between lens 11 and imager 13 to monitor the location of imager 13 in relation to lens 11, and to feed this information to controller 7 thereby providing a control feedback loop to actuator 9. By this means, in addition to providing location data on imager 13, device 15 can provide continuous feedback signals to controller 7 for maintaining imager at the image plane. In addition, it may be necessary to ensure that sufficient resistance to movement is built into imager 13 to provide ample stability to its position during periods when controller 7 is not directing a move through actuator 9.

In one embodiment of the invention, distance measuring device 15 comprises a linear variable differential transformer (LVDT). Other systems of precise linear distance measurement are well known in the prior art.

Whereas Figure 1 shows a system for linear movement of the imager, Figure 2 shows a system where the imager is mounted to rotate about an axis centered at a pivot point 23. The plane of the imager which receives image 19 will be parallel with a radius vector 25 originating from axis of rotation 23. Actuator 21 for this embodiment is a means of causing movement of imager 13 along an arc tangential to optic axis 17 by causing rotation about axis 23. Otherwise, all elements of Figure 2 correspond with those elements shown in Figure 1.

In Figure 2, by proper positioning of lens 11 in relation to the depth of field required for the range of object locations along optical axis 17 and control of the radius of the arc, the length of the arc along the circle of rotation tangential to optical axis 17 can be optimized. Accordingly, the angle of rotation can be held to very small angles. Although some distortion of image 19 can occur, such can be readily taken into account regarding the particular application of this type of system.

For detector 5, a simple device comprising a string of lights installed on one side of object 1 and a parallel string of respective light detectors installed on the other side have been used to detect the height of object 1, i.e., the location of object plane 3. Since object 1 is of the nature that it will block light from being received by some of the detectors depending on the height of object 1, and with these detectors located in a direct relation to the location of lens 11, this device then serves as an appropriate distance measuring device for determining the distance of object 1 from lens assembly 11. Clearly other such distance measurement devices are available in the prior art. Particularly, such devices are quite common in detecting distance to an object in camera photography applications.

Controller 7 is a microprocessor or computer capable of receiving signal information from detector 5 and device 15, and processing this information to determine a control signal for positioning actuator 9 or 21 for proper location of imager 13 to receive a focused image 19. The processor circuitry for processing the imager position signal receives data concerning the distance between object plane 3 and lens 11 from detector 5, and, using data of the imaging properties for lens 11, calculates the location expected for the image plane and produces the drive signal to the actuator required for positioning imager 13 at this image plane.

Figure 3 shows an embodiment of the rotary type but with a modified approach which allows the imager to be maintained in a plane perpendicular to the optical axis 17, although allowing the imager to move transversely within this plane. The imager 33 in this embodiment has been shown as two dimensional type imager which can be achieved through the use of transistor arrays capable of detecting the light emanating from object 1. Imager 33 is mounted to an imager frame 35 which also has attached a printed circuit board 37 which contains the electronics for operation of the focusing system. Frame 43 is fixed with lens assembly 11. A motor magnet 39 is fastened to fixed frame 43. A motor coil 41 is fastened to imager frame 35.

Frames 43 and 35 are connected by flexure bars 31. These flexures allow the frames to move relative to one another while maintaining the plane of imager 33 perpendicular to an optic axis positioned through imager 33. The actuator which provides the force for moving frame 35 in relation to fixed frame 43 is the combination of motor magnet 39 and coil 41. By applying an electrical signal to this combination through coil 41, a force is created which will either pull togeth r magnet 39 and coil 41 or force them apart thereby causing imager 33

to translate back and forth along the optical axis.

Figure 4 presents an embodiment based on the rotating axis technique where the rotating member containing an imager 53 is of a cantilever type which is part of a fixed member 51. Fixed member 51 is a thin plate which can be a printed circuit card which also contains the electronics for the automatic driving circuit. In this manner it can serve as the circuit board for the imager driving electronics including the controller.

A cutout tab 63 is separated from the remainder of plate 51 by a slot 55. Tab 63 cantilevers about axis 61 from the plane of plate 51. Movement of tab 63 is accomplished through an actuator 59 which is attached to plate 51 in a manner to drive tab 63. A slot 57 is constructed through plate 51 along axis 61 in order to minimize any undesired tortional or twisting motion of tab 63 other than about axis 61. This tends to insure that imager 53 will detect image 65 with no distortion along the length of image 65 parallel to axis 61.

As with the other methods actuator 59 may be a linear displacement motor drive system containing a coil and motor magnet. For this embodiment, it is more appropriate to utilize a solid state actuating mechanism such as a piezoelectric driver or another type of electrostrictive or magnetostrictive device for control over movement of tab 63. It should also be clear that imager 53 may be either a linear CCD array or a two dimensional CCD array, or other type of optically sensitive array including thin film transistor arrays sensitive to the radiation being detected.

Figure 5 shows a rotating method which utilizes a speaker voice coil to drive Imager 96 which will rotate about an axis 82. A lightweight frame 84 which holds imager 96 is pivoted to rotate on axle 86 about the axis of rotation 82. Axle 86 is fastened to brackets on the fixed unit containing the lens assembly (not shown). Imager 96 is oriented to intersect optic axis 17 as described earlier.

A moving coil speaker system 88 containing a magnet assembly 90 and moving coil 94 is utilized to drive connecting rod 92 which is connected to move the imager frame 84. It is to be noted in this figure imager frame 84 has been designed to be very lightweight, thereby according it a low mass and making it more responsive to rapid movements for detection of quickly changing object locations along optic axis 17.

Figure 6 shows a complete assembly of an automatic focusing apparatus utilizing a pivoting imager. A lens assembly 102 is fastened to a stationary frame 118 which also holds pivots 114, a stationary circuit board 112, and a stationary motor magnet 104. Resonance or resistance springs 108 are shown connected between stationary frame 118 and pivoting imager frame 116. These resistance or resonance springs are not necessarily needed but may be used to provide a reaction force to movement of the pivoting imager frame thereby making the positioning of imager 100 more positive in action with reduced or no backlash tendencies. Flexural pivots are alternate choices available for reducing any backlash tendencies.

Electrical flex strips 110 are shown connected between imager 100 and stationary circuit board 112 for carrying the signal from the imager 100 to electronics for processing this signal. Stationary circuit board 112 may also contain the controller and provide control signals to the motor coil 106 via flex strips 110 for moving the pivoting imager frame 116.

Imager frame 116 rotates on an axis through pivots 114. Again imager frame 116 has been designed to be extremely light in weight for facilitating rapid reaction to changing image plane locations. Also attached to stationary frame 118 is a linear variable differential transformer 120 which, connected to pivoting imager frame 116,provides a measure of the location of CCD imager 100 in relation to lens assembly 102.

Figure 7 shows the use of an electrostrictive or magnetostrictive device for actuating movement of the imager linearly along an optic axis 17. Here imager 13 is shown fastened to piezoelectric device 97 which itself is attached to fixed frame 99 and which also can hold the fixed lens assembly 11. Controller 7 transmits electrical signals to cause electrostrictive deformation of piezoelectric device 97. Piezoelectric device 97 is cut such that the electrostriction deformation is an expansion or contraction along optic axis 17 thereby moving imager 13 back and forth along optic axis 17 in a manner not to cause deformation of image 19. The use of an electrostrictive device such as 97 will generally preclude the need for a distance measuring device 15 for monitoring separation distance between the imager 13 and lens 11, since such devices are stable and repeatable in their operation.

Figure 8 shows an alternate technique for determining the control for proper positioning of the imager to receive a focused image. A contrast evaluation system 20 is connected to receive the image as focused through lens 11. Processing algorithms which are well known in the art are used to evaluate the quality of the image to determine if it is in focus. The quality of the image can be related to the image contrast characteristics, its sharpness of detail, or other factors which relate to its degree of focus. Based upon this evaluation, a control signal is developed by controller 7 to activate actuator 9 to reposition imager 13 to the plane of the focused image 19.

The above automatic focusing systems and various concepts are useful in the application of

monitoring information on an upper surface of packages traveling at a rapid rate on a conveyor belt. Such use includes reading bar code symbols on mail packages during rapid scanning of a top surface of the mail packages as a conveyor belt moves them past the scanning camera at a rapid rate. Such rate of movement presently can be several hundred feet per minute or faster. Figure 9 displays such a use. Conveyor belt 107 has placed on it several packages identified as 101, 103 and 105. Each package has a different height in relation to the plane of a conveyor belt 107, and therefore are located at a different distances from lens 11 along optic axis 17.

The object 1, for postal monitoring, is usually a bar code located on the upper surfaces 109, 111 and 113 for the respective packages. Information in these bar code symbols provides directions on handling the mail and otherwise. The bar codes will rapidly change their object 1 position relative to lens 11 as conveyor belt 107 moves past the scanning camera; consequently, the need for the ability to rapidly focus image 19 on imager 13 is quickly appreciated.

While these specific embodiments of the invention herein have been illustrated and described in detail it will be appreciated that the invention is not limited thereto, since many modification may be made by one skilled in the art which fall within the true spirit and scope of the invention.

Claims

1. An apparatus for automatically focusing an image (19) of an object (1), the apparatus comprising means (11) for focusing the image onto an image plane (19), means (13) for detecting the image and means (5, 7, 9) for controlling the position of the focusing means relatively to the object (1) and the detecting means (13) to position the image plane (19) substantially at the detecting means (13), characterised in that the detecting means (13) is movable and the controlling means (5, 7, 9) is coupled to move the detecting means with a component of motion in the direction of the optical axis (17) defined by the focusing means (11).

2. An apparatus according to claim 1, wherein the position controlling means (5, 7, 9) comprises means (9) coupled to the detecting means (13) for controllably moving the detecting means substantially along the optical axis (17) and means (5, 7) for controlling the moving mens (9) to move the detecting mens (13) substantially to the image plane (19).

3. An apparatus according to claim 2 wherein the position controlling means comprises means (5) for determining the position of said object along said optical axis and for feeding this information to a control means (7) of the controlling means for determining the location of said image plane.

4. An apparatus according to claim 1, 2 or 3 and which comprises means (15) for measuring the distance between the detecting means (13) and the focusing means (11) and connected to transmit this measurement to the controlling means (7).

5. An apparatus according to claim 4 wherein the means (15) for measuring is a linear variable differential transformer.

6. An apparatus according to claim 4 wherein the means (15) for measuring is a strain gage.

7. An apparatus according to claim 4 wherein the means (15) for measuring is a fiber optic interferometric distance measuring device.

8. An apparatus according to claim 1 or 2 and comprising an image quality analyser (20), the controlling means being operable to determine the position of the image plane along the optical axis from the evaluation of the quality of the image sent it by the analyser (20).

9. An apparatus according to claim 8 wherein the image quality analyser (20) is operable to evaluate the degree of focus of the image on the detecting means to determine the location of the image plane for moving said detecting means thereto.

10. An apparatus according to any one of the preceding claims wherein said focusing means is a lens system.

11. An apparatus according to claim 10 wherein said focusing means is an optical lens system.

12. An apparatus according to any one of the preceding claims, wherein the detecting means is a light-sensitive chemical medium.

13. An apparatus according to claim 12 wherein the light-sensitive chemical medium is a photographic film.

14. An apparatus according to any one of claims 1 to 11 wherein the means (13) for detecting is an electronic image detecting device.

15. An apparatus according to claim 14 wherein the means for detecting is a CCD array (which may be linear).

16. An apparatus according to claim 14 wherein the means for detecting is an optically sensitive transistorized array.

17. An apparatus according to any one of the preceding claims, wherein the controlling means is arranged to move the detecting means linearly along the optical axis.

18. An apparatus according to any one of claims 1 to 16, wherein the controlling means is arranged to move the detecting means along an arc tangential to a line coincident with or parallel to the optical axis.

19. An apparatus according to claim 2 or to any one of claims 3 to 18 when appended to claim 2, wherein the moving means (9) is an electromechanical actuator.

20. An apparatus according to claim 19 wherein the actuator is a magnet-coil assembly (39, 41).

21. An apparatus according to claim 19 wherein the actuator (59) is a motor magnet and coil combination.

22. An apparatus according to claim 19 wherein the actuator is a moving coil audio speaker combination (90, 94).

23. An apparatus according to claim 19 wherein the actuator is an electrostrictive device.

24. An apparatus according to claim 19 wherein the actuator is a magnetostrictive device.

25. An apparatus according to claim 19 wherein the actuator is a piezoelectric transducer device.

26. An apparatus according to any one of the preceding claims, wherein the controlling means comprises an electronic controller (7).

27. An apparatus according to claim 26 wherein the controller is provided by a computer.

28. An apparatus according to any one of the preceding claims, wherein the focusing means is fixed on the optical axis.

29. An apparatus for forming focused optical images of objects at varying distances from the apparatus as they pass by the apparatus along a pre-determined path, the apparatus comprising focusing apparatus according to any one of the preceding claims.

30. An apparatus according to claim 29 for forming focused optical images of symbologies appearing on the surfaces of articles located at varying distances from the apparatus, the apparatus comprising a conveyor for carrying the articles along the predetermined path, a stationary first member held in a fixed position relative to the predetermined path and supporting the focusing means for producing an image of the symbologies on the surface of one of the articles in the image plane as the conveyor carries the articles past the optical element, a second member supporting the detecting means for travel therewith, the second member being movable relative to the first member to selectively move the detecting means along the optical axis and an actuator attached to move the second member relative to the first member in response to a drive signal indicative of the distance along the optical axis between the position of the detecting means and the position of the image plane to adjustable position the detecting means at the image plane.

31. An apparatus according to claim 18, or to any one of claims 19 to 30 when appended to claim 18, and comprising a planar bed holding the detecting means with a receiving surface of the detecting means oriented at a predetermined angle to the plane of the bed, at least one first pivot arm pivotally connected to a first edge region of said planar bed, at least one second pivot arm pivotally connected to a second, opposite edge region of said planar bed, said first and second pivot arms having substantially equal lengths, said first pivot arm being connected at its end region opposite the end region connected to the bed to a first pivot point in a plane parallel to the bed and spaced a predetermined distance from said bed, and said second pivot arm being connected at its end region opposite the end region connected to the bed to a second pivot point in said plane parallel to the bed, said distance between said first and second pivot points being substantially equal to the distance between the connections of said first and second pivot arms to said bed, whereby the edge of the bed, the line between first and second pivot points, and the first and second pivot arms approximately

form a parallelogram.

32. An apparatus according to claim 31 wherein the first and second pivot arms are flexures allowing approximate rotation about the pivot points and points of connection to the bed.

33. A method for automatically focusing an image of an object onto an image plane, which method comprises:
(a) focusing the image of the object onto an image plane with a focusing means fixed on the optical axis of focusing;
(b) detecting said image with a detecting means;
(c) determining the position of the image plane and controllably moving the detecting means to this image plane along the optical axis where an image of the object is in focus.

34. A method according to claim 33 wherein the step of determining the position of the image plane includes the steps of:
(a) determining the distance between the focusing means and the object; and
(b) calculating the position of the image plane using imaging properties of the focusing means.

35. A method according to claim 33 wherein the step of determining the position of said image plane includes the steps of:
(a) evaluating the degree of focus of the image as detected by the detecting means; and
(b) calculating the position of the image plane using empirical algorithms previously determined from measurements with the focusing means.

36. A method according to any one of claims 33 to 35 and comprising the steps of:
(a) placing a first member supporting a stationary optical element at a fixed position relative to the optical axis;
(b) providing a movable second member holding the detecting means;
(c) generating a drive signal indicative of the distance along the optical axis between the detecting means and the image plane; and
(d) selectively moving the second member relative to the first member in response to the drive signal to position the detecting means at the image plane.

37. A method according to claim 36 wherein the second member is moved relative to the first member by pivoting the second member about an axis of rotation to move the detecting means substantially along the optical axis.

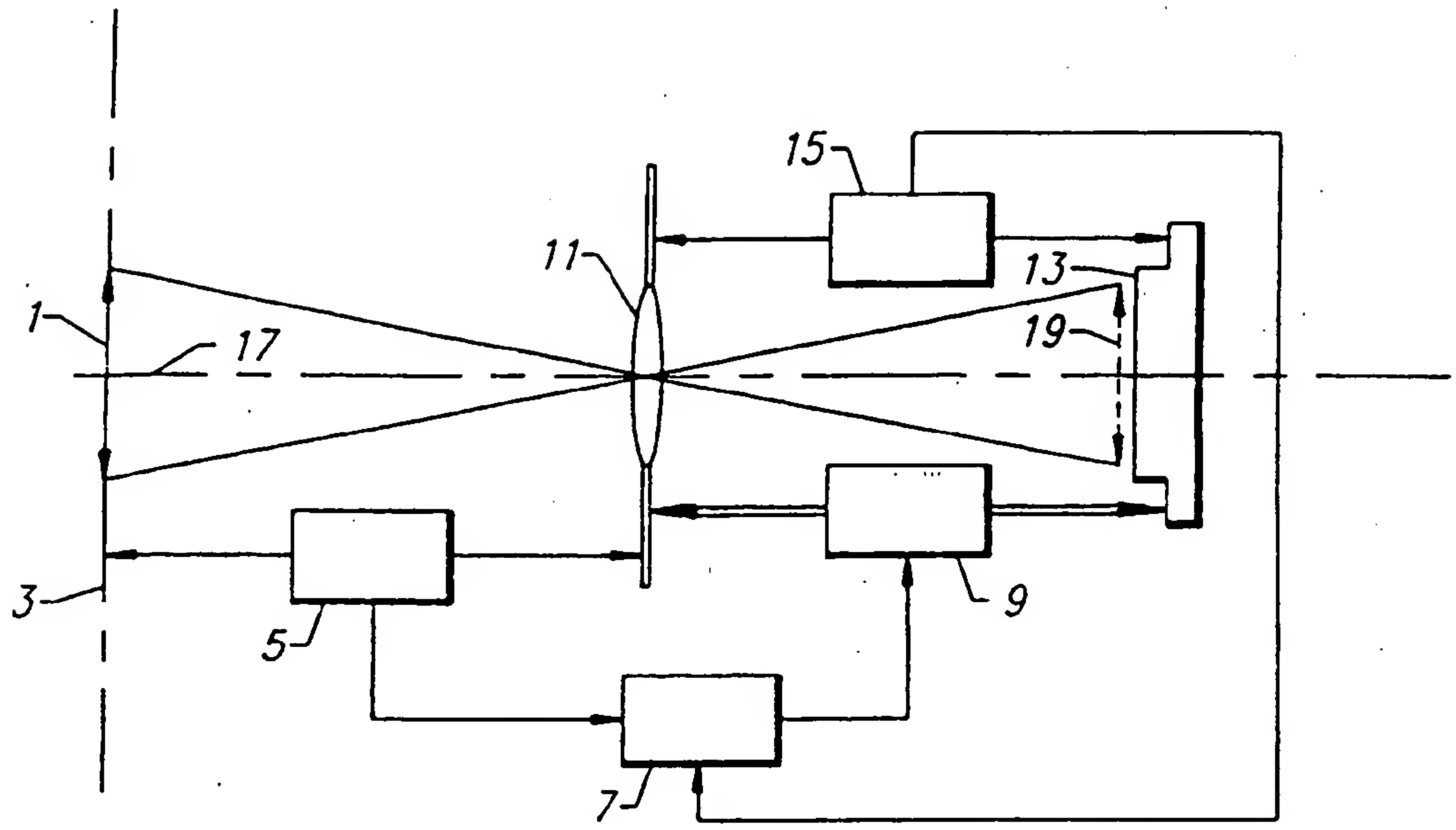


FIG. 1

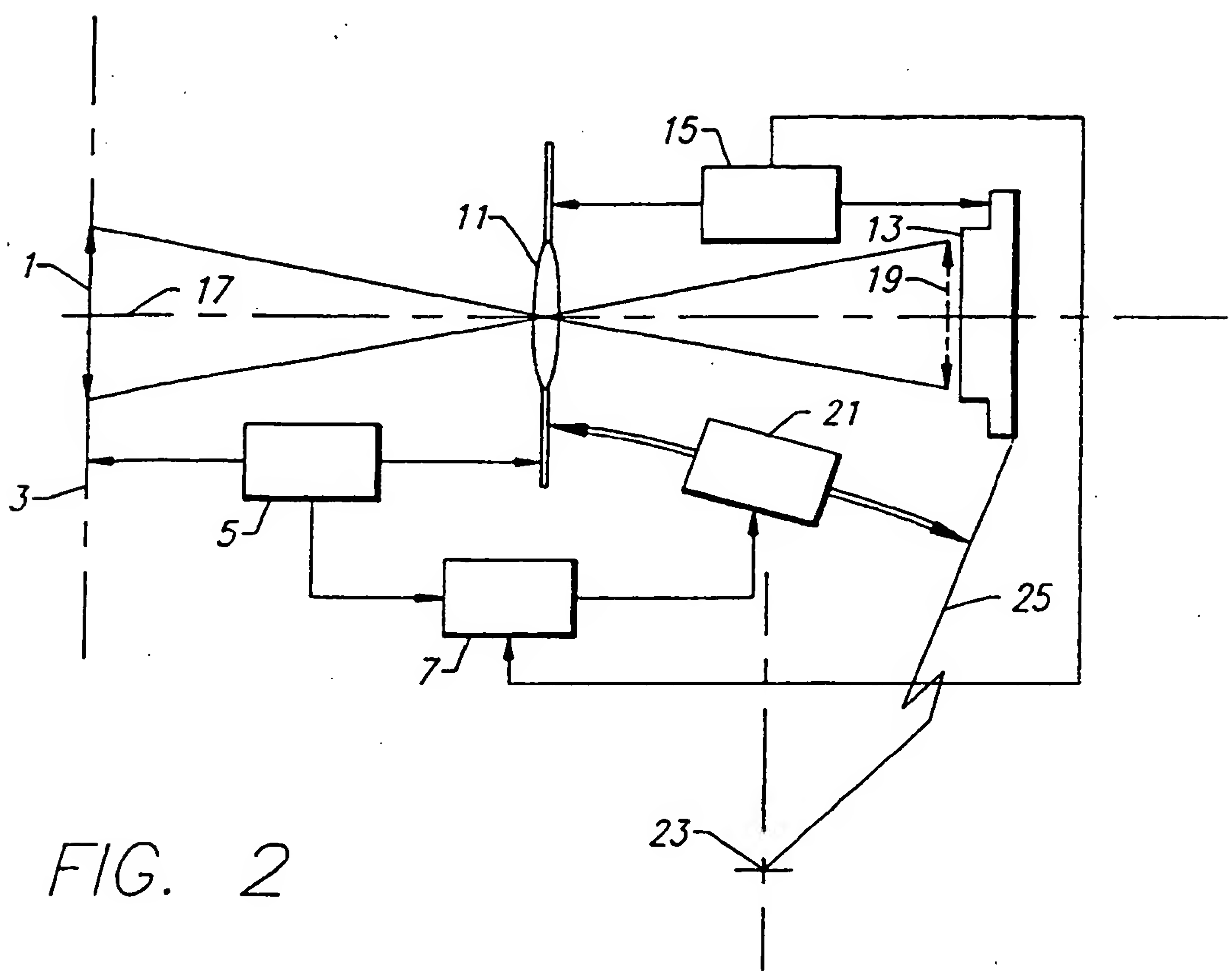


FIG. 2

FIG. 3

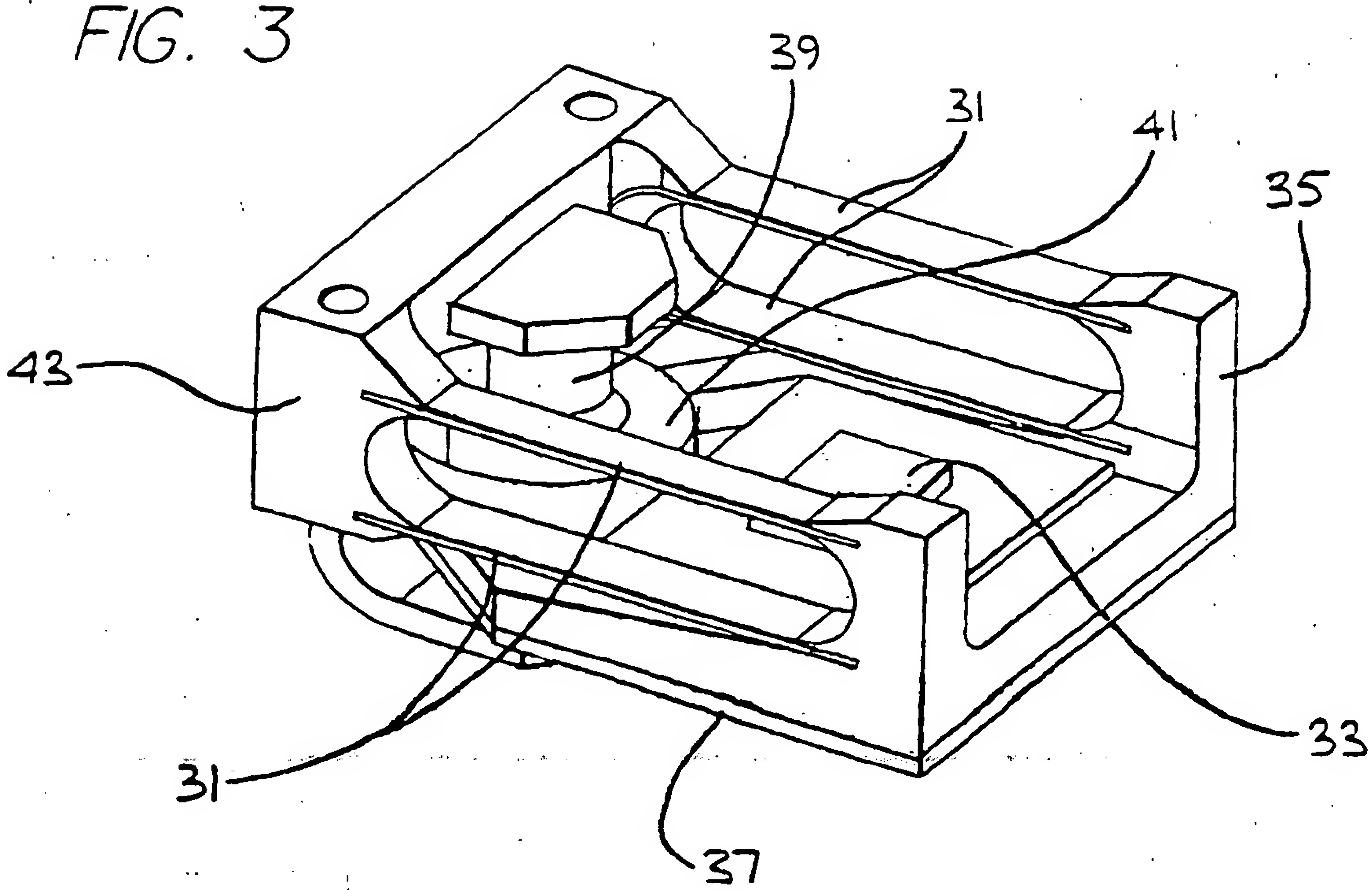


FIG. 4

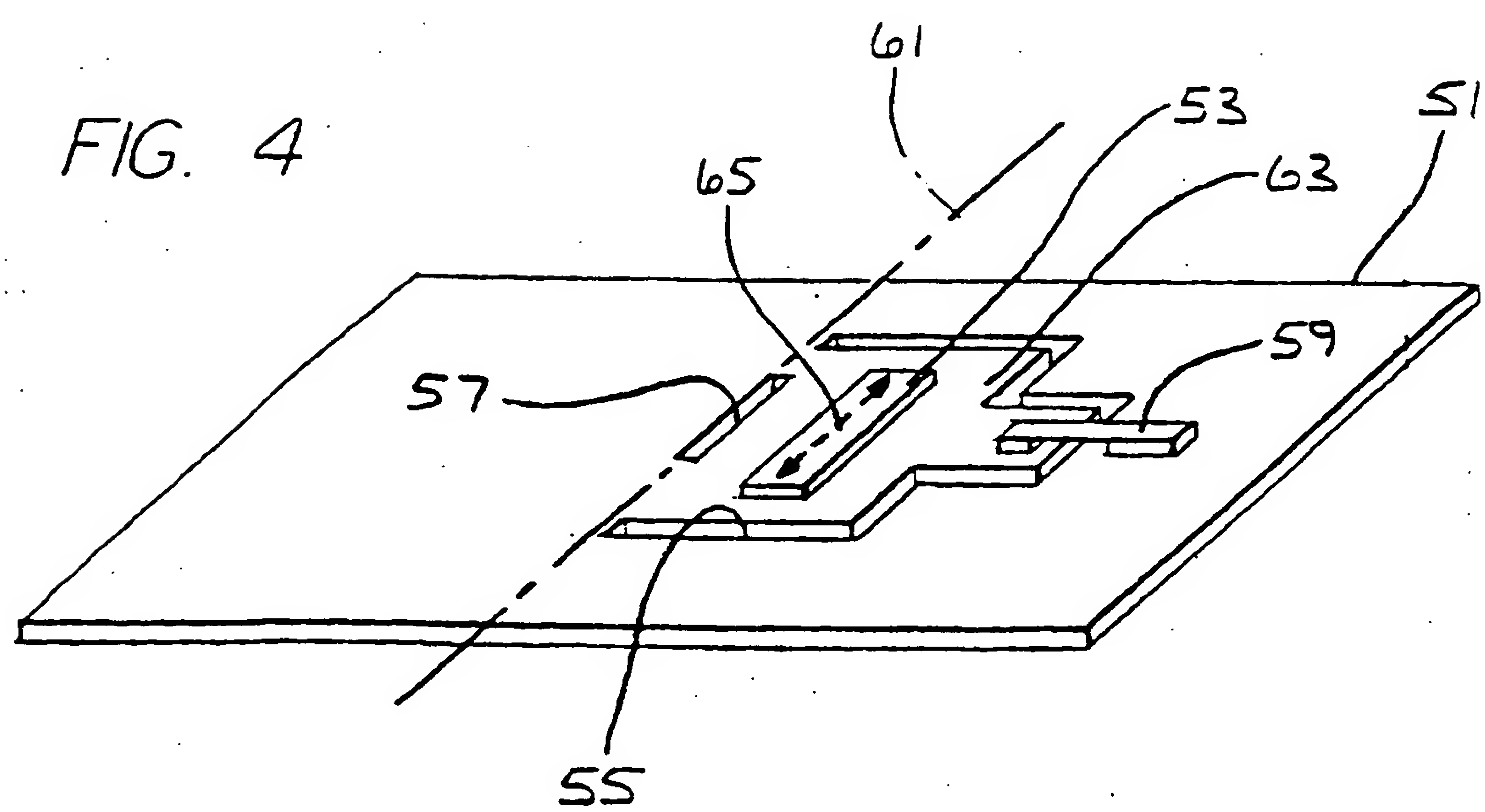
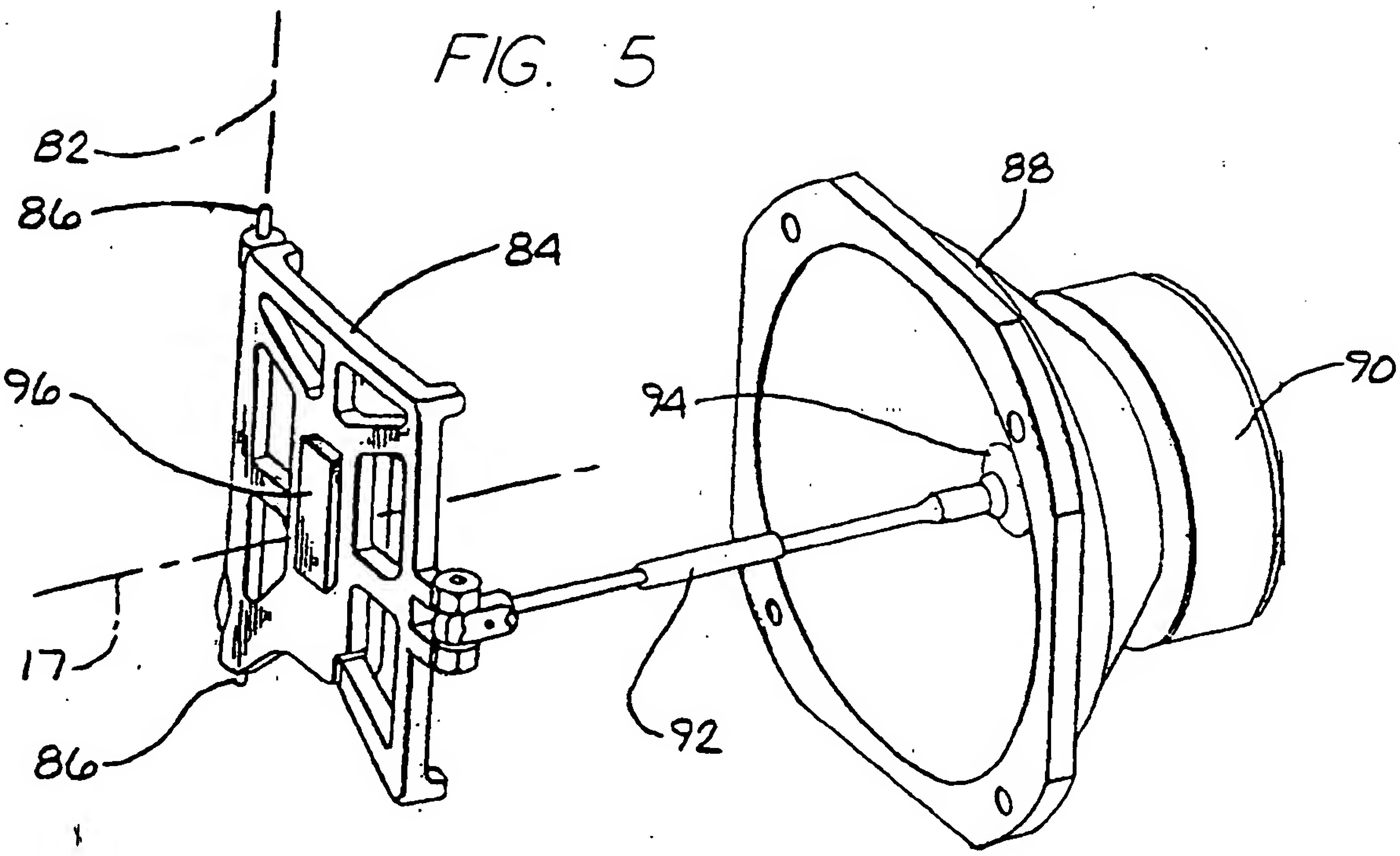


FIG. 5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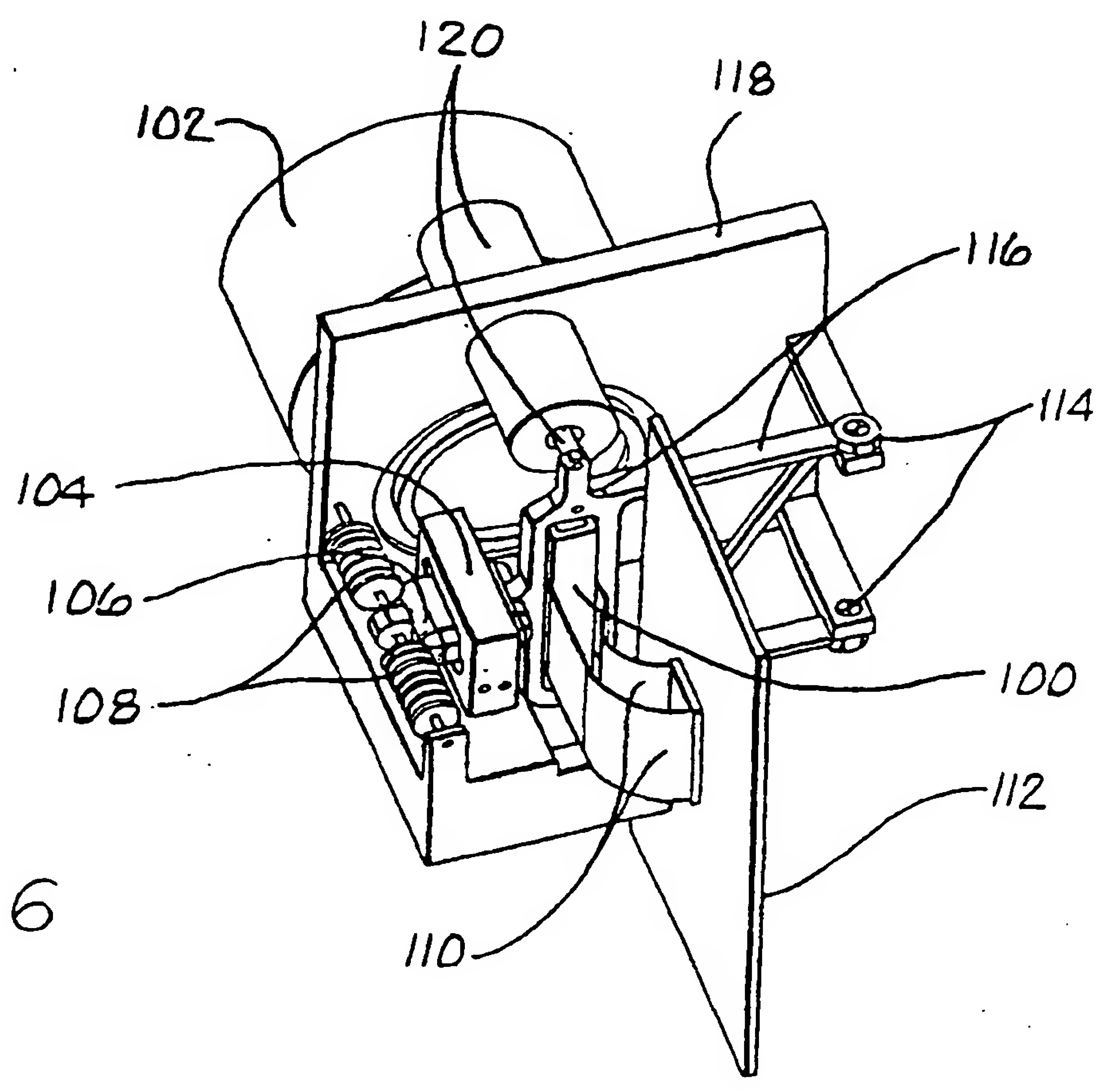
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FIG. 6

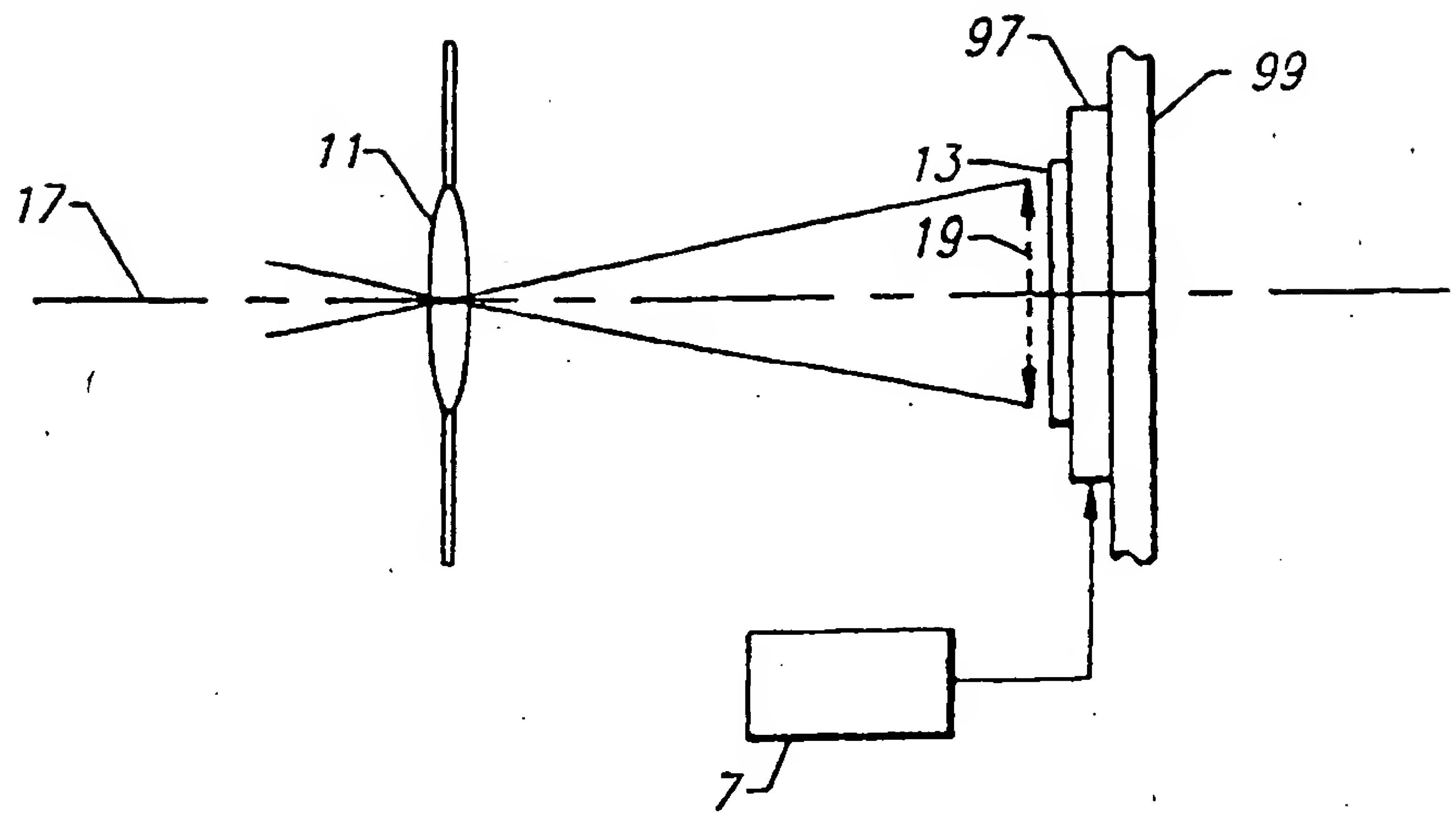

FIG. 7

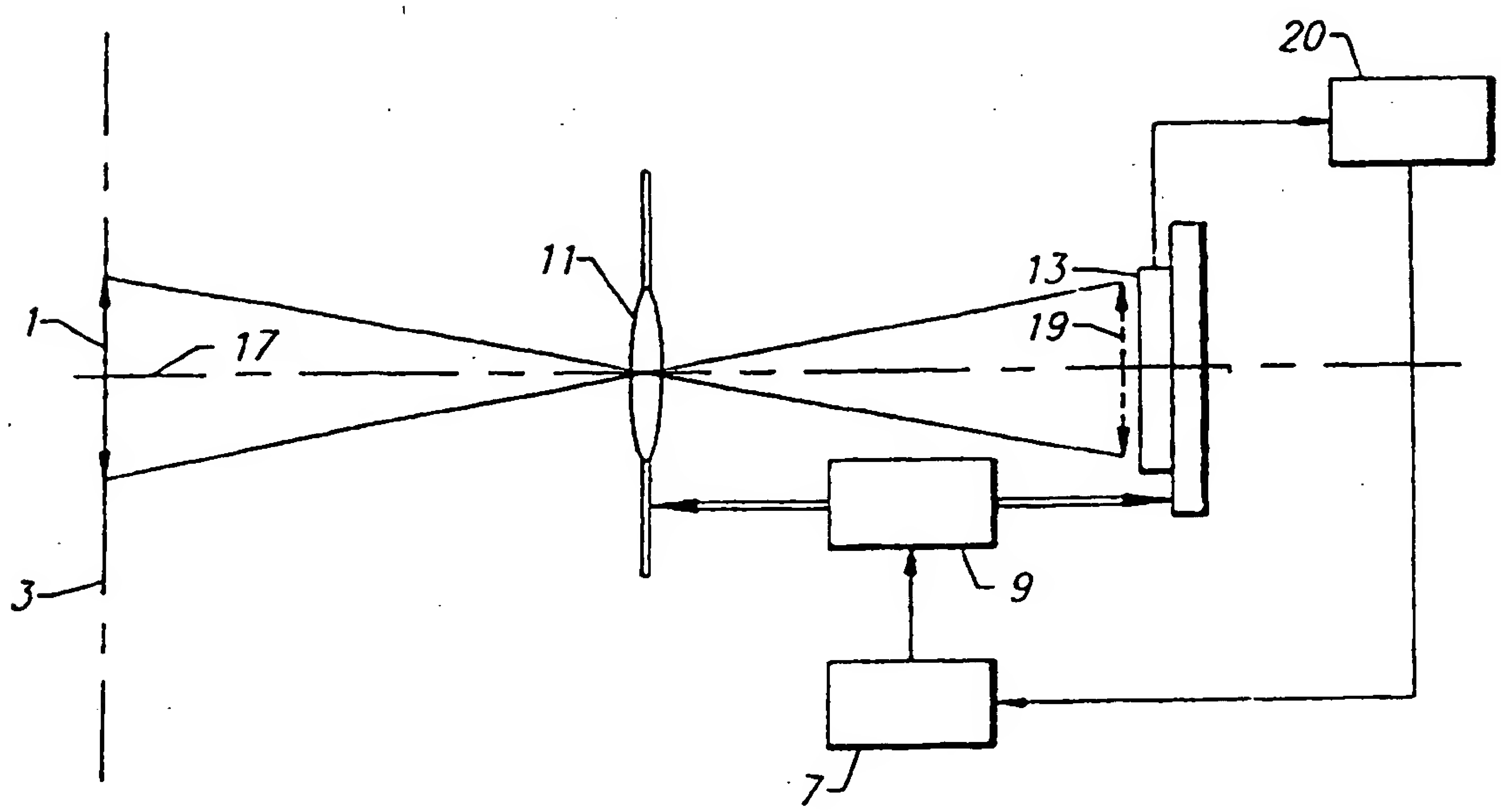

FIG. 8

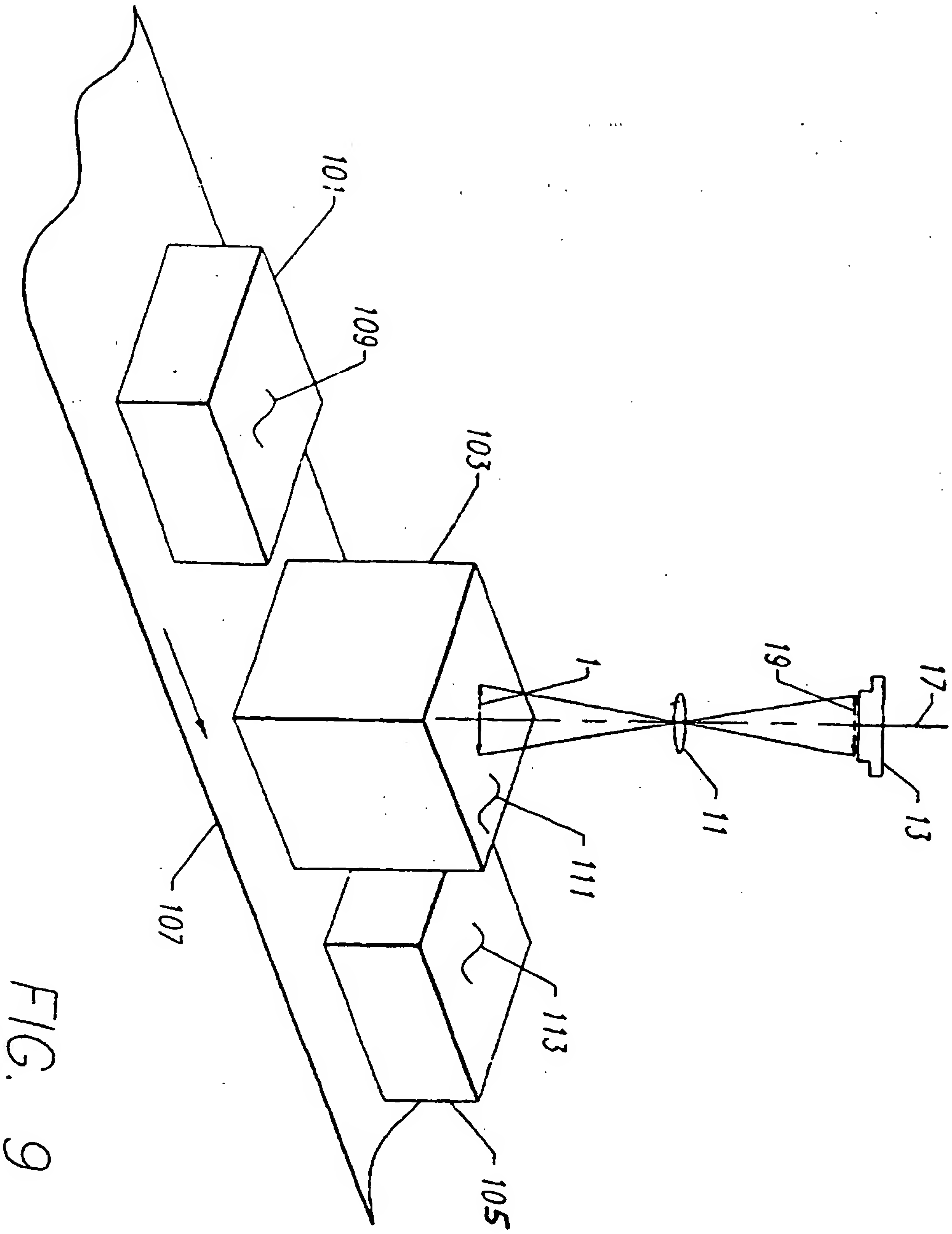

FIG. 9

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 93 30 8633

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	EP-A-0 533 590 (FUJITSU) * page 5, line 6 - page 6, line 25; figure 4 * ---	1-3,8-11,14,17,26,27,28,33,36	H 04 N 5/232 G 02 B 7/36
X	US-A-4 570 185 (ARAI et al.) * column 2, line 46 - column 4, line 57; figures 1,2 * ---	1-3,10,11,14,15,17,20,26,33,36	
X	DE-A-3 243 920 (OLYMPUS OPTICAL) * page 6, paragraph 3 - page 8; figures 1,2 * ---	1-3,10,11,17,19-21,26-28,33,36	
A	PATENT ABSTRACTS OF JAPAN, vol. 12, no. 453 (P-792), 29 November 1988; & JP-A-63175844 (FUJI PHOTO FILM) 20.07.1988 * abstract * ---	1,18,37	TECHNICAL FIELDS SEARCHED (Int. Cl.5)
A	US-A-5 101 278 (ITSUMI) * abstract; figures 1,2,5 * ---	1,23-25,33	H 04 N G 02 B
A	US-A-4 846 155 (KIMURA) * column 2, lines 5-21; column 7, line 53 - column 8, line 23; figures 10,11 * -----	1,19-25,33	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	27-06-1994	VON MOERS F

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
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E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

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